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Archaeological
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METHODS OF DETERMINING THE DATE OF ROMAN CONCRETE MONUMENTS[1]

(FIRST PAPER)

FOR the dating of ancient monuments, the evidence used is of three classes: internal, external, and a third class which may be called variable evidence. With the nature of the second class, the external evidence, which is, for the most part, literary, all are familiar. The evidence which has been called variable is that furnished by decoration or decorative material, by dedicatory inscriptions, and especially by brick stamps. All these, *when incorporated in or belonging to the structure of the monument*, may be accepted as internal evidence; when, however, they form a nonstructural part of the building or are merely attached to it, they cannot be given more weight than that of external evidence.[2] Upon the second of the three classes, that of external evidence, the conclusions of the earlier writers on topography were almost wholly based. Since the beginning of the new era of excavation, however, increasing attention has been paid to the third, or variable, class of evidence,

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[1] The discussion presented in this and in the following article is merely a preliminary study for a more exhaustive treatment of the subject to be published later. On account of the vastness of the field and the small portion of it as yet investigated, the results here given, especially the canon, or norm, of construction for the different periods, though in the main features certain, must inevitably be modified and corrected in many details by later investigation.

[2] Such evidence, however convincing it may appear, cannot by itself be regarded as conclusive. The distinction here suggested is especially vital in dealing with brick stamps. Brick stamps, in order to be accepted as authoritative evidence in dating a monument or part of a monument, must be found not only *in situ*, but incorporated in a structural part of the building and that, too, of the original building. Even then, on account of the use at all periods, whenever feasible, of old material, the evidence of brick stamps is of value only in establishing a *terminus a quo* for the date of the erection of a building. Lack of attention to these facts has led to many of the present errors in the chronology of the monuments.

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especially by that famous group of German scholars of which Jordan was the center, whose important work forms the basis of our present knowledge of the chronology of the ancient monuments. The first class, that of purely internal evidence, has received, up to the present time, but little attention.

Internal evidence may be considered, in general, as of four kinds. The first of these is that established by the relation of the building or portion of a building in question to the buildings above and below it, as well as to those adjoining it on the same level, — in brief, the structural environment of the monument.[1] Evidence of the second kind rests upon the harmony — or the absence of harmony — in the general plan of the building itself, and the architectural relation of the various parts of it to each other and to the whole. The third class of evidence is that drawn from the structural unity or lack of unity of the monument, as well as from the uniformity or diversity of its materials and methods of construction, while the fourth is furnished by the character of the materials and by the methods of construction.

The realm of knowledge dependent upon the study of the last two kinds of evidence, especially that dealing with the character of the materials and the methods of construction, has remained up to the present time, in large part, a *terra incognita*, although, from time to time, excursions, most often merely tentative, have been made into it.[2] A more exhaustive investigation in this field, more especially concerning the materials themselves and the methods used in concrete structures, has seemed, therefore, of primary importance, in order to confirm or, if need be, to correct the conclusions which have been drawn from the other and time-honored classes of evidence. The purpose of the investigation has been twofold: (1) the study of the materials and methods of construction *per se*, and (2) the establishment of a fixed canon, or norm, of construction for the various periods, by which the accepted chronology of the concrete monuments already known may be tested, and dates assigned more easily to new-found or as yet undated monuments.

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[1] Concerning the structural environment, especially the level and orientation, of the monuments excavated at an earlier time and now inaccessible, if not destroyed, exact data are almost wholly wanting. The present administration is marked by the endeavor to render the records more nearly complete in these as in many other important details.

[2] Among the earlier works, those of Nibby and Corsi alone are conspicuous: Antonio Nibby, *Dei Materiali impiegati nelle fabbriche di Roma, delle costruzioni, e dello stile* (*Roma Antica*, I, pp. 234 ff.). Faustino Corsi, *Delle pietre antiche*. The introductory chapters of Middleton's *Remains of Ancient Rome* (1892) merit special mention, on account of the writer's sympathetic treatment of the problems involved and accurate technical knowledge of the material dealt with. As a general discussion of the subject, Durm's *Die Constructionen* (*Baukunst der Etrusker und Römer*, 1905, pp. 179 ff.) is invaluable. A number of recent works, also, dealing with individual monuments or groups of monuments, promise a new era of more accurate observation. Conspicuous among these is the work of Germain de Montauzan, *Les Aqueducs antiques de Lyon*, Paris, 1909.

Roman concrete structures are divided, for the sake of convenience, into two classes, those made (1) of unfaced and (2) of faced *opus caementicium*.[1] In the first class may be included (1) foundations and substructures, for monuments both of *opus quadratum* and *opus caementicium*, (2) *podia*, (3) free-standing walls which, from their position or use, were regarded as substructures, and (4) vaults. The second class may be divided into walls faced with *opus quadratum*, *opus incertum*, *opus reticulatum* (including *quasi reticulatum*), *opus testaceum*,[2] and *opus mixtum*. In dealing with monuments of the second class, the body of the structure and the facing must be considered separately, since the distinctive characteristics — the "earmarks" — of the various periods are to be found now in the one and now in the other. There are cases also, which are by no means rare, where a wall of a certain period has been refaced at a later time. A notable example of this occurs on the south side of the exedra of the Hippodrome on the Palatine, where a considerable stretch of wall of the period of Domitian has been covered by a facing of the time of Septimius Severus. This facing, in its turn, is at present in danger of yielding place soon to a modern one, as can be seen in the following illustration (Fig. 1).

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[1] The name used by Vitruvius for the whole class of construction is *caementicia structura* (*De Arch.* II, IV, 1; II, VII, 5). *Opus caementicium*, which occurs in inscriptions (*C.I.L.* III, 633), has been, however, adopted in this discussion, since it is already in use.

[2] The *structura testacea* of Vitruvius (*l.c.* II, VIII, 17, 18) may be included under this general heading. It differs, however, from *opus caementicium* faced with *opus testaceum* in that the name refers primarily to the body of the wall, the *caementa* of which are of the same material as the facing.

The body of a Roman concrete structure, whether faced or unfaced, is composed of pieces of stone, called by Vitruvius *caementa*,[2] or of brick laid in a bed of mortar, which together form a solid unified mass,[3] the *opus caementicium* of the Romans (Fig. 2). The *caementa* vary much in material and in size, in the different periods, as well as in the manner of their disposal in the mass. In the periods marked by a full mastery of the

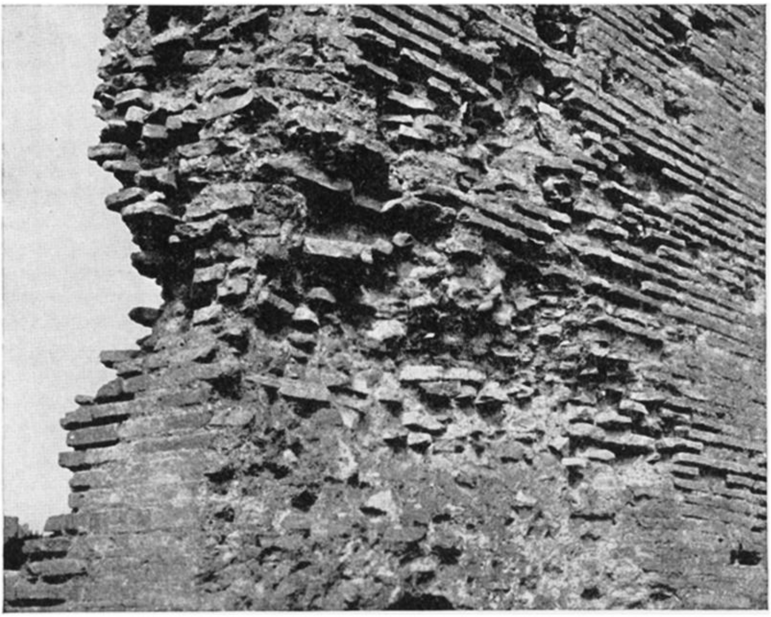

Figure 1. — A Refaced Wall.[1]

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[1] The facing of larger bricks on the left is of the time of Domitian; the finer facing on the right is the work of the period of Severus.

[2] *L.c.* II, IV, 3; II, VIII, 1, 2. In the *structura caementicia* of Vitruvius, the *caementa* were wholly of stone. When roof-tiles were used, the mass was called by him *structura testacea.* The use, for this purpose, of bricks other than those made from tiles did not even arise, at least in Rome, till after his time. For the sake of simplicity, the term *caementa* is used here, however, for all forms of filling.

[3] The concrete construction of the Romans should not be confused with modern rubble, from which it differed essentially.

technique of the construction, the *caementa* differed also, according as they were used in foundations and *podia*, free-standing walls, or vaults. Since they consist, in great part, of the rejected or broken materials of the preceding period, they furnish, in many cases, valuable data, not only concerning the monument in which they are found, but also concerning the earlier building of which they formed a part. In the Regia of Calvinus,[2] for example, the *caementa* of the lower walls, contrary

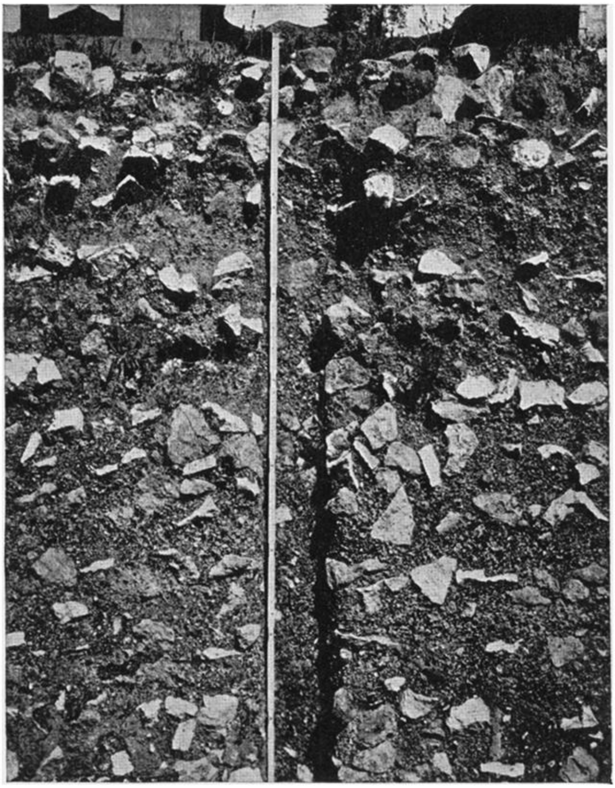

FIGURE 2. — AN UNFACED WALL OF OPUS CAEMENTICIUM OF THE PERIOD OF NERO.[1]

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[1] The section of wall here shown is from one of the massive concrete substructures on the Velia (see Platner, *Topography and Monuments of Ancient Rome*, 1911, pp. 311–312).

[2] 36 B.C.

to the rule of the period,[1] consist wholly of large pieces of *cappallaccio*, the inferior tufa which was used almost exclusively in very early buildings. We may safely conclude, therefore, that the earlier building which the Regia of 36 B.C. replaced had retained wholly or in part its very primitive walls.

The mortar is composed of *pozzolana*, which is called by Vitruvius *arena fossicia*,[2] and lime. The data derived from this *pozzolana-arena*, the varieties[3] of which used in the various periods differ widely, are often of great importance. A most striking example of this is to be found in the monuments of the Augustan period, in which one of the distinctive characteristics of the construction, the dusky red color of the mortar,[4] arises from the use in it of a special variety of *pozzolana*,[5] the introduction of which by Augustus, or by his predecessor Julius Caesar, marks an epoch in the history of concrete construction. The lime also differs much, in the various periods, in quality[6] as well as in quantity.[7]

The facing of concrete monuments varies greatly in the different periods. With the increase of knowledge in the manufacture and use of concrete, or *opus caementicium*, as we may more safely call it, and the corresponding decrease in the structural value assigned to squared stone, or *opus quadratum*, arose the use of the latter as a mere facing. In consequence of this change, certain structures, for reasons of economy, were left practically unfaced,[8] or were faced with small stones, as a substitute for the more costly *opus quadratum*. In place of this facing of small stones, the *opus incertum* and *opus reticulatum* of the late republican and Augustan periods, brick-facing was introduced. With this class of concrete monuments, especially those faced with brick, the present discussion is, in the main, concerned.

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[1] See the following article for the period of Augustus.

[2] *L.c.* II, IV, 1. The name *pulvis Puteolanus*, the modern *pozzolana*, was confined by the ancients to the volcanic earth found near, or shipped from, Puteoli (Seneca, *Quaest.* III, 20, 3 ; Pliny, *N. H.* XXXV, 167). The volcanic origin of the *pozzolana* found near Rome, as well as many of its most valuable properties, were unknown to Vitruvius.

[3] For the varieties of *pozzolana*, see Vitr. *l.c.* II, IV, 1.

[4] See the following article, for the period of Augustus.

[5] The *arena rubra* of Vitruvius (*l.c.* II, IV, 1).

[6] See Vitruvius, *l.c.* II, V.

[7] For the proportion of lime in the Augustan period, for example, see Vitruvius, *l.c.*

[8] In the earlier *opus incertum*, the character and arrangement of the pieces of stone forming the facing do not differ materially from the character and arrangement of the *caementa* in the body of the wall. The structure may be regarded as in a technical sense unfaced.

In the facing of concrete structures of this last type, the bricks used in Rome are of two distinct kinds. The first of these is that made from broken *tegulae*,[1] or flanged roof-tiles, and, at a later time, from the larger floor-tiles called *tegulae bipedales*.[2] These bricks, to which may be applied the name tile-bricks, are roughly broken except on the front side, which is evenly sawed.[3] In the earlier periods, they are more often irregularly trapezoidal in shape; but after the introduction of triangular bricks they tend to approach the triangular form. The bricks which are made from roof-tiles are conspicuous for their fine composition, even, close-knit texture, and clear magenta-red[4] or light yellow color; those made from *bipedales* — which belong to a much later period — are of coarser composition and vary considerably in color. The bricks of the second kind used in wall-facing are triangular in shape, and, in Rome, are made by sawing diagonally into two pieces smaller square tiles, or bricks, measuring from 19–22 cm.[5] Outside of Rome, notably in Pompeii and Sicily, square tiles of various sizes were used, which were sawed into four triangles.[6]

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[1] Vitr. *l.c.* II, VIII, 19.

[2] *L.c.* V, X, 2; VII, IV, 2.

[3] The use of the saw in the manufacture of facing bricks was clearly recognized by Piranesi (*Ant. Rom.* III, Tab. V.), though he failed to recognize the various kinds of bricks so treated. The presence of sawed roof-tiles in wall-facings is recognized, also, by Boni (*Atti del. Cong. Stor.* V, 55 f.). Cf. Mau's description of the tiles used in the Rostra Augusti as *zurechtgehauene Stücke von Dachziegeln* ('Rostra Caesaris,' *Röm.Mitt.* XX, 3, p. 258). The use of sawed bricks is very common in Pompeii, also.

[4] The color is hard to define. It tends, however, toward brownish rather than yellowish red.

[5] These square tiles, though in the early empire they usually exceed 20 cm, in size, are probably the *laterculi bessales* (0.197 m.) recommended by Vitruvius (*l.c.* V, X, 2) for the building of hypocaust pillars. Of their use in wall-facing, there is no trace in his work.

[6] The two types are easily distinguished. In the Roman triangles the front side alone is sawed, while in the others the two shorter sides are sawed or, in Pompeii, broken, and the front is moulded.

A large number of *bipedales*, marked for sawing, are to be found in both the large and small theatres at Taormina (Fig. 3). A few others, also similarly marked, were seen by me several years ago, in a Roman villa in Corfu. These triangular bricks in Rome are far less fine in composition and texture than the roof-tile bricks and vary in color from reddish yellow to a deep yellowish red.

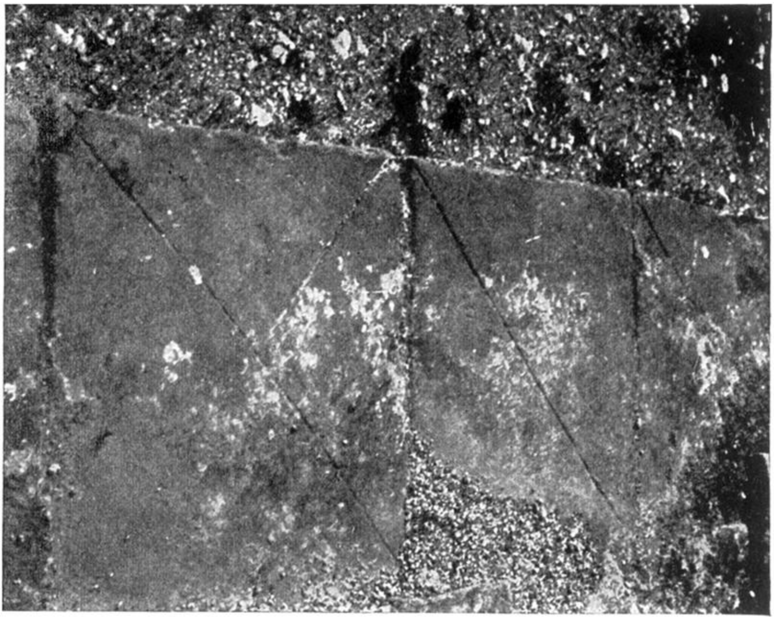

FIGURE 3. — BIPEDALES IN THE LARGE THEATRE AT TAORMINA.

In deciding the date of any ancient monument, after a consideration of the external and variable evidence concerning it, its level and orientation and its structural relation to the adjoining monuments must also be determined. Passing, then, to the monument itself, it is necessary first to ascertain whether it consists of a single building or of a group of buildings.[1] For the determination of this question, an examination must be made not only of its architectural plan but also of its structural unity. This structural unity — or better, the lack of it — is seen most clearly in the facing, though it is often almost as apparent in the body of the monument. It is shown (1) by a break in the continuity of the concrete mass itself or of the facing, causing often a noticeable crack[1] (2) by a change in the materials and methods of construction, or (3) in both these ways. In the body of the building, if no marked difference exists in the type of construction, the break in structural continuity is almost impossible to detect. In the facing, on the other hand, when the break occurs in a straight stretch of perpendicular wall, it is very apparent. When it occurs, how-

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[1] For an example of a complex group of buildings, see Van Deman, *The Atrium Vestae*, Washington, 1909, Plan E.

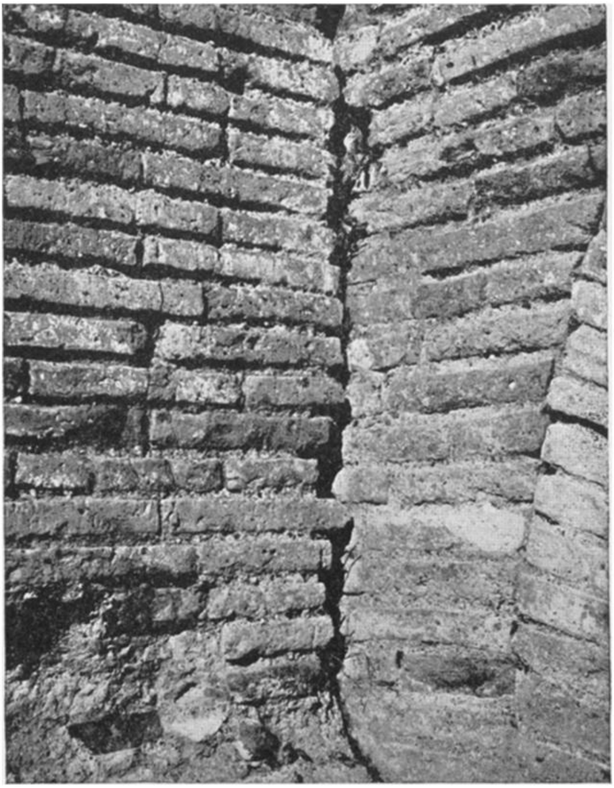

FIGURE 4. — WALLS OF DOMITIAN AND HADRIAN IN THE DOMUS AUGUSTANA.[2]

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[1] See Fig. 6.

[2] The wall on the right is of the period of Domitian, while that on the left is of the time of Hadrian.

ever, between the stories of a building, or at a corner, as in the accompanying illustration (Fig. 4), it is more difficult to discover, unless accompanied by a noticeable change in material and methods of construction. This difficulty is often still further increased by the presence of a form of false bonding,[1] by which the line of juncture of the two walls was concealed and the parts bound more closely together. A change in the materials and methods of construction is far more readily detected. It is traceable, in the body of the structure, (1) in the difference in the material and size of the *caementa*, or filling, as well as in the manner of their disposal in the mass, and (2) in the composition, color, and cohesion of the mortar.[2] In the facing of the structure, the change is very clear where the types of construction have no superficial resemblance to each other, as in certain remains on the Velia (Fig. 5), in

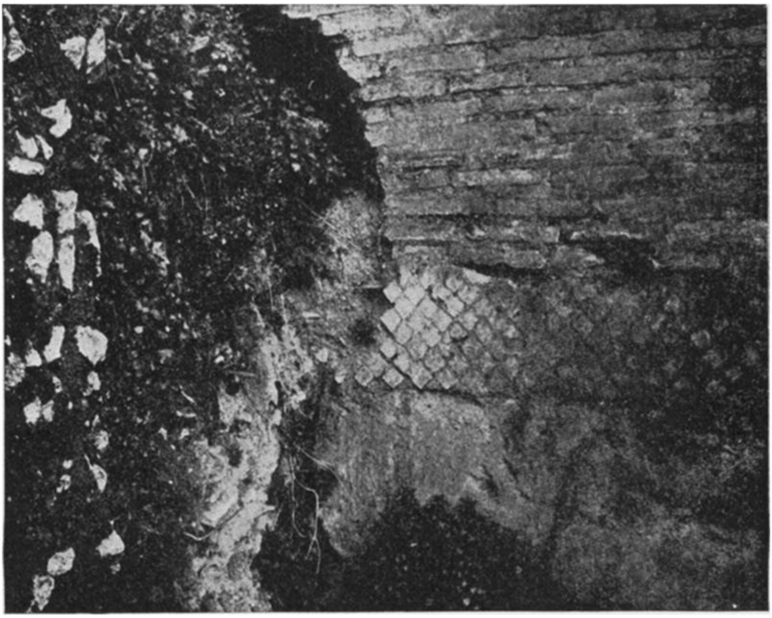

FIGURE 5. — REPUBLICAN AND IMPERIAL WALLS ON THE VELIA.

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[1] See Fig. 4.

[2] Variation in the color of the mortar, as well as many other differences in material, can be most easily detected when the walls are damp.

which the earlier wall of *opus quadratum* has been used as a foundation for one of *opus caementicium* faced with *opus reticulatum*, which, in its turn, has been partly replaced by a later wall faced with brick. The change is less plain where the facing is wholly of brick; it is, however, traceable in the size and kind of bricks used, as well as in the thickness of the joints of mortar and in its composition. Where both a break in the continuity of the mass or of the facing and a change in the type of construction are found, the lack of structural unity and, in consequence, the complex character of the monument are clearly apparent, as in the illustration from the Atrium Vestae given above (Fig. 6).

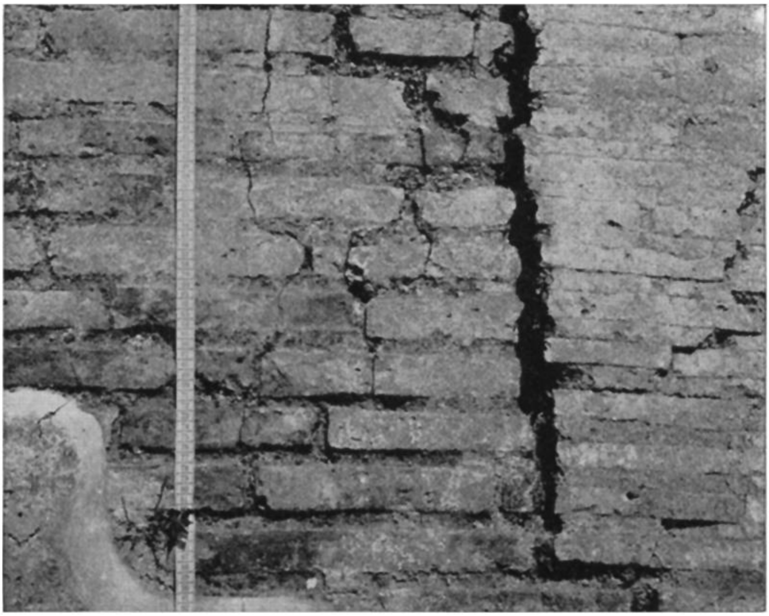

FIGURE 6. — BRICK-FACING OF THE PERIODS OF DOMITIAN AND SEPTIMIUS SEVERUS.[1]

The simplicity or complexity of the structure having been determined, — in monuments of *opus caementicium* by no means an easy task, — an examination of the internal evidence bearing more directly upon the date or dates of the building is possible. In such an examination a fixed standard, or norm, for each period is necessary, with which the materials and methods of construction used in the monument or in the several parts of it may be compared. The establishment of this standard, or canon, has been, as has been said,[1] one of the main purposes of the present investigation.

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[1] The wall on the left is of the time of Domitian, and that on the right, of the period of Septimius Severus. See Van Deman, *Atrium Vestae*, pp. 21 ff., 43 ff.

For the determination of the data upon which this canon should be based a list was made of all the monuments made wholly or in part of *opus caementicium* which still exist or of which an authoritative record has been kept. A special examination was then undertaken of all those still existing to which, on the basis of external or internal evidence, a fixed date has been assigned. In the case of each of these monuments, so far as it has been possible, the examination has included the following points: (1) the orientation and, where ascertainable, the original level of the building, (2) its structural environment, (3) its architectural plan, and (4) its structural unity. On the basis of the results thus obtained a list of the monuments of *opus caementicium* in each of the greater periods has been compiled, which, though depleted by the loss of a few familiar names found in the handbooks on topography,[2] is yet sufficiently large for the purpose in hand. A preliminary outline of the main features of this canon, so far as they are at present determined, is here given.[3]

I. The Kingly and Earlier Republican Period (753–210 B.C.)

Of the kingly and earlier republican period but a few remains are left to which even an approximate date can be assigned. From these, however, it is clear that the same type of construction, which is a ruder form of *opus quadratum*, was continued unchanged throughout the whole period. The material used in the earlier part of the period is *cappellaccio*, the friable gray tufa found on the slopes of the Palatine and Capitoline, as well as on most of the other hills of the city. The blocks used in the courses are low and broad, and the unit of measure employed is the Italic foot of 0.275 m. The walls seem in all cases to be laid without mortar.

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[1] P. 232.

[2] Several of the more important of these monuments will be discussed in later articles.

[3] The canon of the imperial periods will be presented in a second article.

The principal monuments of this more primitive type, concerning some of which, however, considerable doubt prevails, are the following: the portions of the so-called Servian Wall made of *cappellaccio*,[2] the Tullianum, the foundations of the temple of Jupiter Capitolinus, the ancient cisterns on the Palatine,[3] the lower part of the Regia and of the lacus Curtius,

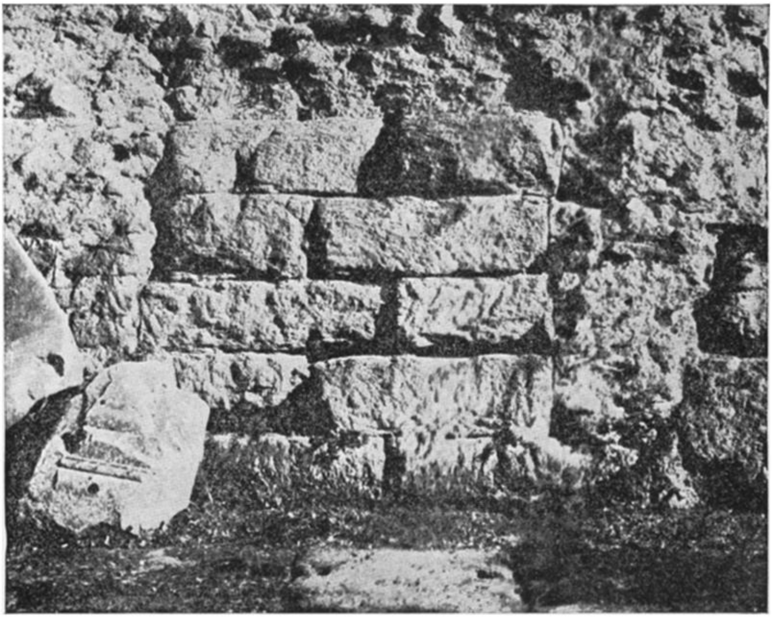

FIGURE 7.—OPUS QUADRATUM OF THE FIFTH CENTURY.[1]

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[1] The blocks of *opus quadratum* are of the temple of Castor of the fifth century B.C. The *opus caementicium* immediately surrounding them is of the temple of 117 B.C.

[2] In addition to the small fragments of this wall on the Palatine (Hülsen-Jordan, *Top.* p. 37, n. 17) and on the Capitol (*l.c.*), a fine stretch of it on the Quirinal was found several years ago (*Not. Scav.* 1907, pp. 504–510; 1909, pp. 221–222); a part of this is still visible.

[3] Platner, *l.c.* p. 132.

the republican Rostra of the first period,[1] the earlier sacellum of Venus Cloacina, and the temple of Castor of the first period (see Fig. 7), with the earlier Fons Juturnae.[2] From their level and orientation, certain other monuments in the Forum and on the Palatine may be assigned to the same period. The most important of these are the pavements and sewers of *cappellaccio* at the lowest level in the Forum.[3]

The rebuilding of the city which followed its partial destruction by the Gauls in 390 B.C. is probably traceable in a small group of remains, which, while agreeing in their general character with those just described, differ somewhat in details. The type of construction is, as in the earlier buildings, *opus quadratum.* For the *cappellaccio* of the more primitive walls, however, other and somewhat less friable kinds of tufa were substituted, especially a light brownish red and a grayish yellow variety, both of which are very porous and weather badly. The blocks are much higher than in the walls of *cappellaccio;* the unit of measure employed is the Greek foot of 0.296 m. The principal monuments of this group are the later portions of the Servian wall and a few unidentified buildings on the Palatine.

II. THE LATER REPUBLICAN PERIOD (210 B.C. – the period of Sulla)

In the fire of 210 B.C., a large portion of the center of the city was again destroyed. With the erection of the new monuments, in the period following this catastrophe a new era of construction began. Throughout the period *opus quadratum* remained the common type of construction for monumental structures.[4] Finer varieties of tufa were, however, used and the technique reached a high grade of excellence. Peperino and travertine were both introduced in this period, though the latter was as yet employed very sparingly. Foreign marbles were imported also, but not until very late in the period. The most important monument in *opus quadratum* in the period is the Aqua Marcia, built in 144 B.C.[1]

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[1] Hülsen-Carter, *Roman Forum*, pl. V, *Rostra Vetera.* The level of the so-called tomb of Romulus and the square foundation behind it, as well as their type of construction, forbid their inclusion among the oldest monuments of the Forum. The original level of the cippus is uncertain; without this the period is difficult to determine.

[2] The type of construction of the earlier Fons Juturnae is not absolutely certain.

[3] This level is 10.6–10.8 m. above sea-level. A discussion of the levels of the Forum and Velia will be published later.

[4] Less important monuments and private houses were built of sun-dried bricks (*lateres*, *lateres crudi*) until the time of Augustus (Cic. *De Div.* II, 47, 99, Suet. *Aug.* 28, Dio Cass. XXXIX, 61).

While, however, *opus quadratum* remained the prevailing mode of construction, the period is marked by the first appearance, in Rome, of concrete, or *opus caementicium*, as a structural building material.[2] The exact time of its introduction cannot be fixed. The first dated monuments in which it has as yet been found are the *podia* of the temples of Concord and Castor,[3] of 121 and 117 B.C.[4] The full mastery of technique in the handling of the new material, as shown in these structures, makes it safe to assume, however, that a knowledge of its use antedated by a considerable period the time of their erection. We may, therefore, assign its introduction to the middle, if not the early part, of the second century. The new material was probably introduced in the first place, as a mere core for buildings of *opus quadratum*. With increasing knowledge of the relative value of the two types of construction, however, the parts shifted and the *opus quadratum* became subsidiary in importance, having, often, little value beyond that of a facing. Before the end of the period, for this more expensive type of facing one of small stone was substituted, to which was applied the name of *opus incertum*.[5] The exact date of its recognition as a distinct structural factor cannot be determined. It is clear, however, that it was so regarded before the end of the period, that is, before the time of Sulla.

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[1] For a full discussion of the technique of this as well as the more important monuments of the following period, see Delbrück, *Hellenistische Bauten in Latium*, Strassburg, 1907.

[2] The use of *opus signinum* anticipated, doubtless, that of *opus caementicium*. Since it cannot be regarded, however, as a structural building material, it has not been included here.

[3] See Fig. 7 ; the concrete surrounding the *opus quadratum*.

[4] The date of the existing remains of the temple of Magna Mater on the Palatine is as yet uncertain.

[5] The term *opus incertum* is used by Vitruvius (*l.c.* II, VIII, I), followed by many modern writers, to designate the body as well as the facing of the structure. To avoid confusion, it is here applied only to the facing.

In the mass, or body, of the structure, the monuments of *opus caementicium* throughout the period show but little change, either in materials or methods of construction. The *caementa* consist largely of the broken or rejected materials from the earlier periods. They are, therefore, almost entirely of tufa, *cappellaccio* and grayish yellow tufa being used in large quantities, with a small amount of the later grayish brown and brownish red varieties. No travertine, bricks, or marble appear, and only occasional pieces of peperino. The pieces are usually above medium size, often exceeding in their greatest diameter 40 cm. No order is shown in their disposal in the mass. The mortar is of an ashy gray type and is very friable.[1] The *arena* used in it varies much in color, gray and brown predominating, while red is almost wholly lacking. It resembles a fine gravel rather than the ordinary *pozzolana*, being composed of smooth instead of sharp-angled particles.[2] These particles vary much in size, and a large amount of earthy matter is mixed with them. To this admixture of earthy matter in the *arena*, which is, for this reason, called by Vitruvius[3] *terrosa*, is due mainly the friability, as well as the gray color, of the mortar as a whole. The lime is of a very dirty-white color, due probably to the earthy character of the *arena;* the proportion of lime is also much smaller than in the later periods.[4]

The earliest dated monument in *opus caementicium*, the podium of the temple of Concord (121 B.C.), is, strictly speaking, unfaced, since the pieces of tufa forming the so-called *opus incertum* of the facing do not differ materially, either in themselves or in their arrangement, from the *caementa* in the body of the structure. The facing of the other monuments, so far as it can be determined,[5] is of *opus incertum* made of the friable tufa of the period.

The more distinctive characteristics — the "earmarks" — of the structures in *opus caementicium* of the period are the following: (1) the very early type of the materials used in the body of the structure as *caementa*, as well as the absence among them of travertine, bricks, and marble; (2) the ashy color and friability of the mortar; (3) the use, in the facing, of *opus incertum*, and its early character, as seen both in the materials used and in the technique.

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[1] For the mortar of the next two periods, see pp. 247, 249.

[2] Sharpness (*asperitas*) is emphasized by Vitruvius (*l.c.* II, IV, 1, see below, n. 3), as by modern builders, as an essential quality of the best *arena*.

[3] *L.c.* II, IV, 1; *quae autem terrosa fuerit non habebit asperitatem.*

[4] For the proportion of lime in the time of Augustus, see Vitruvius, *l.c.* II, V, 1.

[5] The facing of the temple of Castor has been wholly destroyed. See Fig. 7.

No complete list has been made as yet of the monuments of the period. The most important of them are: the temple of Concord of the second period, the temple of Castor of the second period, the arches behind the Fons Juturnae, and the so-called *Carceres*.

III. The Period of Sulla

Of the works of Sulla as a builder, as well as of the imposing monuments erected by others in his period, a large number are preserved outside of Rome, especially in Palestrina, Tivoli, and Pompeii. The splendid public buildings with which he sought to adorn his capital, on the other hand, are represented only by a few uncertain remains. Of the greater monuments erected by others, also, but one is left, the Tabularium, built by Q. Lutatius Catulus in 78 B.C.

From the character of the monuments erected during the period, it is probable that the majority of them were built wholly of *opus quadratum*. The remains of a goodly number of such monuments, built of the earlier tufas, are, in fact, assigned to Sulla himself, though the proofs are in no case conclusive. In the Tabularium, the only dated monument of the time, both types of construction are used,[1] the substructures and inner walls being of *opus caementicium*. Both types of construction are used also in a small group of monuments in the Forum,[2] which, from their level and structural environment, may be assigned to this general period. No exact date, however, can be assigned to them at present. They have not, therefore, been included in the present discussion, though they agree, except in type of facing,[1] with the work of the period.

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[1] It is, however, commonly spoken of as of *opus quadratum*.

[2] These monuments are the following: the republican Rostra of the second period (Hülsen-Carter, *Roman Forum*, pl. V, "*Rostra Palicani*"), the arches behind the Rostra Augusti, and a number of unidentified remains along the Sacra Via. The lacus Curtius of the second period and a number of fine pavements of grayish brown tufa are of this same time: they are, however, wholly of *opus quadratum*.

The outer walls of the Tabularium, which, from its agreement in construction with the Sullan monuments outside of Rome, may be accepted as typical of the period, are of *opus quadratum*. The material used is almost wholly peperino, though travertine is employed very sparingly in the colonnade.

The massive substructures and inner walls are, as has been said, of *opus caementicium*. The *caementa* are almost wholly of brownish red tufa, with little admixture of older materials. The pieces vary considerably in size but are usually large. They are laid without special regard to order. The mortar is of the ashy gray type, but is slightly less friable than that of the preceding period. The *arena* is darker in color and a little less *terrosa* than earlier. No change in the lime is perceptible. The walls are practically unfaced.

IV. THE PERIOD OF JULIUS CAESAR

With Julius Caesar a new era in Roman construction begins. Succeeding to the great plans of Sulla, he formed even greater ones, spurred on, during the earlier years, by the rival efforts of Pompey to win favor with the people by gifts of magnificent public monuments. With the carrying out of these plans,[2] which included the reconstruction of the Forum, its extension by the erection of the Forum Julium, and the building up of the Campus Martius, a new system of construction gradually arose. The period, however, though marked by this gradual development of new ideas, retained throughout many of the earlier republican methods. It may be called, therefore, the period of transition.

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[1] The facing is, in part, of *quasi reticulatum*, which is not found in the Sullan monuments in Palestrina; it is used, however, in certain of the buildings of the period in Pompeii.

[2] A better opportunity for the carrying out of his plans was afforded Julius Caesar by a destructive fire in 54 B.C. (Orosius, VI, 14), which laid waste a considerable part of the city. Too little attention has been paid to this as well as to the other fires of this general period.

Opus quadratum without admixture of *opus caementicium* was retained in certain monumental structures, as the Basilica Aemilia, the Tabernae Novae,[1] and the Forum Julium.[2] The materials used almost wholly in these buildings are grayish brown tufa and peperino, with travertine for points of special pressure. In the Basilica and Tabernae, however, the earlier grayish yellow tufa is retained for the foundations. The technique is of a high order. A thin layer of lime is used between the courses to make the fitting of the joints closer. In the larger number of public monuments both types of construction were used, *opus caementicium* being used, as in the Tabularium, for the more massive portions of the structure, while *opus quadratum* was still retained for the external walls and also for the points of special pressure. To this class of monuments belong the theatre and porticus of Pompey, the theatre of Marcellus,[3] and, in all probability, the Curia and Rostra Julia. The dawn of the new era is shown most clearly, however, by the increasing prominence given to the third class of monuments, those made wholly of *opus caementicium.* The most conspicuous examples of this class are the *cuniculi* of the Forum (Fig. 8), the concrete foundation near the Equus Domitiani,[4] and a small group of private houses, of which the earlier Domus Liviae on the Palatine is the most important.[5]

The monuments of the period — so far as it has yet been possible to classify them[6] — which are made wholly or in part of *opus caementicium* may be divided into two classes. These classes are most easily distinguished by the mortar, which, in the one class, is of a gray color, resembling the ashy gray type of the earlier monuments, though a little darker, while in the other class it is grayish red, approaching more nearly the mortar of the Augustan period.

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[1] The Tabernae Novae were regarded as distinct from the Basilica Aemilia until a much later time than is usually supposed.

[2] The vaults of the rooms, or shops, adjoining the Forum Julium are of *opus caementicium.* Since the foundations of the Forum are inaccessible, the type of construction used in them is uncertain.

[3] The theatre was finished by Augustus.

[4] Hülsen-Carter, *l.c.* 144.

[5] The other members of the group are: the private house on the slope of the Palatine in front of the so-called temple of Jupiter Victor (the lower walls), the house on the Esquiline containing the frescoes representing the *Odyssey* landscapes, and the house near the Villa Farnesina.

[6] For the rooms adjoining the Forum Julium and the theatre of Marcellus the data are not complete.

In the body of the structures of the first class the *caementa* are, in large part, of *cappellaccio* and other friable tufas, the refuse material from the earlier periods;[1] a small amount of the later tufa appears, however, and a very little travertine.

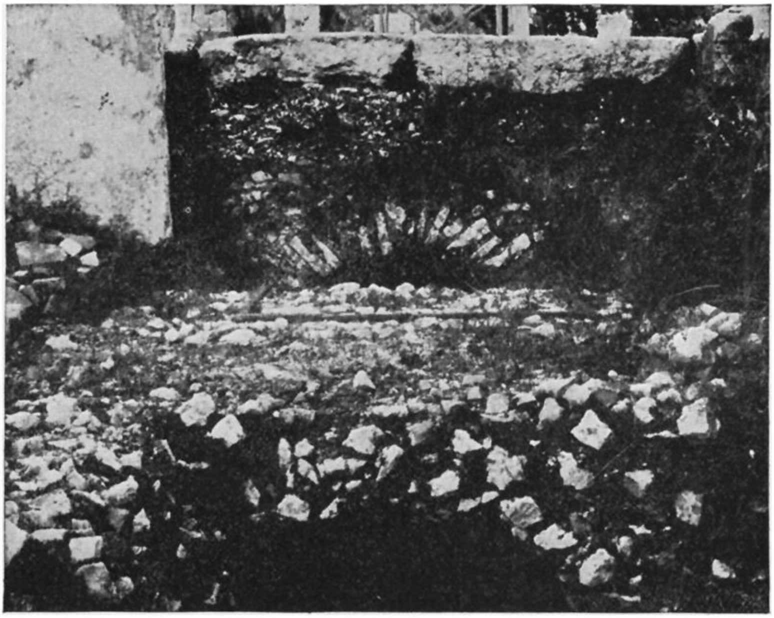

FIGURE 8. — THE CUNICULI AND THE EQUUS DOMITIANI.[2]

No bricks or marble are found. The pieces vary much in size and are laid with no apparent attempt at order.[3] The mortar differs but little in color from that of the Sullan period, but is superior in quality, being of a finer texture and harder. The *arena* is of the same general type as earlier but less *terrosa.*

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[1] In the private houses the amount of older material found is much less than in the other monuments.

[2] The arch in the background is a restoration of the vault of one of the *cuniculi.* The foundation of *opus caementicium* in front is that of the Equus Domitiani.

[3] In the Rostra Julia are found several thin strata of marble chips marking the width of the sections made at one time.

The lime is of a slightly better grade and is more abundant; it retains, however, the dirty-white color of the earlier periods. The monuments belonging to this first class are the foundations of the Curia Julia, the Rostra Julia,[1] the Domus Liviae of the earlier period, and the lower walls of the house below the so-called temple of Jupiter Victor.

In the *opus caementicium* of the second type the *caementa* vary, as in later periods, according to the nature of the structure in which they are used. In the inner walls[2] of the theatre of Pompey they are of the same brownish red tufa of which the facing is made and are of medium size. In the *cuniculi* and the massive foundation near the Equus Domitiani, which is of the same period,[3] the *caementa* are almost entirely of travertine and *selce*, as in the foundations and substructures of the later periods. They are of medium size and are laid with no attention to order. The mortar is grayish red and is almost entirely free from the friability of the earlier type. The *arena* is a true *pozzolana*, consisting of sharp-angled particles, which vary much in size and are often very large. It is but slightly *terrosa*. The color differs greatly from that of the arena of the earlier periods; reddish brown and dark gray predominate, but there is also much red. The lime is much cleaner and more abundant than in the earlier type of mortar.

Opus incertum as a facing does not appear in any monument of the period. Its occasional use at a later time is, however, referred to by Vitruvius.[4] In its place appears, in both classes of structures, the more elegant *opus reticulatum*, the rise of which may be assigned to this period.[5] The bits of stone, or tesserae, of which it is formed are very small,[6] measuring usually 4 cm.–6 cm. across the face. They are made commonly of brownish red, though occasionally of the older grayish yellow tufa. The *cuniculi*, except the sides of the square shafts in the vaulting, and the monument near the Equus Domitiani are unfaced.

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[1] See Van Deman, *The So-called Flavian Rostra*, *Am. Jour. of Arch.* XIII, pp. 178–179, 186.

[2] The foundations of the theatre are not accessible.

[3] The evidence concerning the date, afforded by the level and by the structural relation of the monument to the *cuniculi* and to the Augustan pavement above it, is conclusive.

[4] *L.c.* II, VIII, 1: *Structurarum genera sunt haec, reticulatum quo nunc omnes utuntur, et antiquum quod incertum dicitur.*

[5] According to Nibby (*Roma Antica*, I, p. 275), *opus reticulatum* was first used in the theatre of Pompey.

[6] A tiny tessera recently found measures but 3 cm. across the face.

The main characteristics of the *opus caementicium* of the period are the following: (1) the darker gray or reddish gray color of the mortar and its freedom from the friability of the earlier type; (2) the appearance of *caementa* of travertine and *selce*; and (3) the use of *opus reticulatum* as facing, as well as the small size of the pieces of stone of which it is composed.

The principal monuments of the period, made wholly or in part of *opus caementicium*, are as follows: the theatre and porticus of Pompey (55 B.C.), the Forum Julium (54 B.C.; the vaults of the adjoining rooms), the Curia Julia (52 B.C.; the foundations), the Rostra Julia, the *cuniculi* (finished by Augustus), the foundation near the Equus Domitiani, the theatre of Marcellus (finished by Augustus), the *Horti Caesaris*, the earlier Domus Liviae on the Palatine, the private house on the slope of the Palatine below the so-called temple of Jupiter Victor (the lower walls), the so-called "house of the Odyssey landscapes," and the house near the Villa Farnesina.

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